TECHNICAL NOTE

U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

SELENIUM POISONING

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Selenium in the Soil

Seleniferous soils have been identified in many regions in the western part of the United States.

Soils capable of supporting seleniferous vegetation have been found only in arid or semi-arid regions where the mean annual rainfall is less than 20 inches, and so is insufficient to leach out water-soluble selenium compounds. High rainfall probably accounts for the fact that no seleniferous vegetation has been reported east of Kansas.

The occurrence of selenium has been shown to be correlated with certain geological formations. The seleniferous formations studied have been found to range in age from Pennsylvanian to Recent (Beath, et. al., 1953). These formations and accompanying seleniferous plants have been found throughout 15 western states.

During the Cretaceous period there was extensive volcanic activity that left volcanic sediments, which are now believed to have contained selenium in the molten rock stage. This would account for the presence of selenium in weathered Cretaceous soils. Some tertiary formations have selenium because they were originally Cretaceous soils.

Other possibilities of selenium sources are the influences of land plants, marine organisms, and selenium-accumulating plants.

The chemical forms of selenium are not definitely known due to the small amounts of selenium in the soil. About fifty percent of the soils tested have shown about two ppm.

Selenium may be present, in part at least, as a primary constituent of the igneous rock from which the sediments were derived. In this case the selenium is likely to be present as a selenide. Selenium may otherwise be present as a selenide in association with iron sulfide. Elemental

selenium may be present in small amounts since fungi, algae, and bacteria are capable of reducing selenites and selenates to the elemental forms. Some soils have selenium in the form of insoluble selenides associated with sulfides.

Selenium is sometimes present in water soluble forms that are immediately available to the plants. Selenium may also be present in soils in three forms that become available to plants only by slow processes of hydrolytic action. These are free selenium, selenides, and basic ferric selenites.

Selenium in the Plants

The accumulation of selenium by a plant is dependent upon two groups of conditions: (1) the selenium-accumulating power of the plant and (2) the selenium-supplying power of the soil. Each of these, in turn, depends upon a number of other factors.

I. Selenium-accumulating power of the plant, depending upon:

   A. Species of plant
   B. Phase of growth
   C. Physiological condition of the plant

II. Selenium-supplying power of the soil, depending upon:

   A. Nature of selenium compounds dissolved in the soil solution.
   B. Concentration of the selenium compounds in the soil solution.
   C. Kinds and concentrations of other substances present in the soil solution.

The ability of a plant to accumulate selenium may be expressed by the ratio of the selenium in the plant to the selenium in the soil solution. This accumulation ratio is determined chiefly by the physiological nature of the particular species of plant (Trelease and Beath, 1949).

Absorption by plants of large amounts of selenium brings about various symptoms of injury, including stunting of growth, changes in color of the foliage, withering and drying of leaves, and premature death of the plant.

The various chemical forms of selenium supplied have different degrees of toxicity, and the toxic effects may be modified by the substances, particularly sulfates, accompanying the selenium compound (Shrift, 1958).

Selenium Indicator Plants

It was early noted by Wyoming investigators that eight species of native plants always contained selenium when collected on soils derived from certain geological formations laid down in Cretaceous and Eocene periods

(Beath, et. al., 1934). Field evidence from collections in fifteen of the Western States has shown a definite correlation between the occurrence of the selenium accumulators and the presence of selenium in the soil.

Native seleniferous plants may be conveniently placed in two broad groups, primary and secondary (Beath, et. al., 1953).

Primary absorbers. This group includes those native plants that are believed to require selenium for normal growth. Representative plants include all of the species in the genera Stanleya, Xylorrhiza, and Oonopsis. Also, certain species of Astragalus are placed in this group.

Secondary absorbers. This group may be defined as those which are generally seleniferous if rooted in selenium-bearing soils, but which are not confined in their growth to such soils. Representative plants in this group include several Aster species, Machaeranthera ramosa, Sideranthus grindelioides, Castilleja sp., Gutierrezia sarothrae, Atriplex nuttallii, and A. canescens.

Converter plants. These plants are seleniferous plants that convert the normally unavailable selenium into forms which can be taken up by other groups of plants.

Selenium Poisoning in Animals

Most of the highly seliniferous plants are rather unpalatable to livestock. Odors, tastes, and individual preferences are the main reasons highly toxic plants are not readily taken. Forage plants that are moderately toxic, and not having offensive odors, are the most dangerous.

Pathology. In acute poisoning the outstanding pathologic changes were necrosis and hemorrhages due to capillary damage. In sub-acute poisoning various degrees of repair and early fibrosis were observed in all the organs. Chronic selenosis was subdivided into two groups: "blind staggers and alkali disease." In blind staggers on a low grade, chronic injury, an acute exacerbation was superimposed. The tissues showed chronic degenerative changes with acute toxic reaction. In alkali disease, chronic, toxic degenerative changes were observed in all organs, and acute irritation was absent. (Rosenfeld and Beath, 1946).

In all cases there is a sloughing of hoofs and horns. Also, a loss of hair is noted.

Acute poisoning. At the onset, the movement and posture of the animal become abnormal. Dark, watery diarrhea usually develops. The temperature is elevated to 103° or 105° F. The pulse is rapid and weak. Respiration is labored, and there may be bloody froth from the air passages. Bloating is accompanied by abdominal pain. Urine excretion is greatly increased.

The pupils are dilated. Before death there is complete prostration and apparent unconsciousness. Death is due to respiratory failure. The duration of the illness is from a few hours to several days (Trelease and Beath, 1949).

Chronic poisoning. Blind staggers shows three stages. The first is a tendency to wander, frequently in circles. In this stage the body temperature and respiration are normal. The animal shows little desire to eat or drink. Sometimes evidence of impairment of vision is noticed.

The second stage is an increased desire to wander. The animal insists upon going forward and will not swerve to miss an object. The temperature and respiration are still normal. There is an increase in blindness. There is no desire to eat or drink.

The third or last stage prior to death is a paralytic stage. The tongue and the mechanism of swallowing become partially or totally paralyzed. The animal is nearly blind. Respiration becomes labored and accelerated. There is great abdominal pain accompanied with grating of the teeth. The body temperature is subnormal. The cornea is distinctly cloudy. The immediate cause of death is respiratory failure (Trelease and Beath, 1949).

Prevention and Control

The effects of poisoning can be reduced by feeding the animals a ration high in protein and vitamin A. Recovery generally takes about 30 days. Caution should be taken to feed iodine-free salt in selenium areas. Iodine will increase the susceptibility of animals to selenium poisoning.

The following control measures, if followed, will reduce livestock loss, toxicity of crops, and possible danger to public health.

First, all seleniferous areas should be mapped with indications of degrees of toxicity on each area. Ranchers should be able to recognize poisonous range plants. Withdrawal of toxic areas to crops and grazing should be followed. The symptoms of selenosis should be known and treatments should be studied.

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